International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN (P): 2249-6890; ISSN (E): 2249-8001
Vol. 9, Issue 6, Dec 2019, 943-950
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TRANS STELLAR
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EFFECT OF PALM OIL BIODIESEL-DIESEL BLENDED FUELS ON ENGINE PERFORMANCE AND EMISSION CHARACTERISTICS

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ABSTRACT

In this experiment, an attempt was made to the analyze the Simpsons make DI tractor engine running on Diesel, B100 and B20 blend in terms of performance and emission characteristics. ASTM standard testing methods were followed for finding the fuel properties. The cylinder peak pressure was noticed as 90 bar, 88 bar and 81 bar, respectively for Diesel, B100 and B20. Further, it was noticed that NOx emissions of B100 and B20 were increased in trend when compared to reference fuel.

KEYWORDS: Diesel Engine, Biodiesel Blend, Performance & Emission

Received: Sep 10, 2019; **Accepted**: Sep 30, 2019; **Published**: Dec 03, 2019; **Paper Id**.: IJMPERDDEC201979

Original Article

1. INTRODUCTION

With the growth of population and the subsequent energy utilization in the world, conventional fuels are declining day by day. The rapid increase in the fossil fuel consumption is resulting into climate change, which is considered as the most important environmental impact. Fossil fuels burning are contributing to produce pollutant gases like NOx, CO_2, and it gives negative effects on the environment. The recent survey indicates that the greenhouse gas emissions are the one to rise the global temperature in the atmosphere. Due to the uncertainties in petroleum supply and increased environmental concern and their high prices have accelerate vigorous exploration of substitute for a conventional fuels. Need of Alternate Fuels are the essential inputs for economic development, social growth, human benefit and quality life of every country. The energy demands from the world are rendered by fossil based resources, such as gasoline, kerosene, diesel and natural gas etc. Therefore, it is essential that minimum emission of alternative fuels is to be developed to use in CI engines to meet the current energy demands. Noor et.al [1] reviewed the usage of biodiesel fuel for marine diesel engine as one of the alternative fuel. Che Mat et.al [2] investigated the diesel engine performance and emissions running on SVO and its blends. Vegetable oil biodiesels and their composition and specifications were analyzed by [3]. Based on the outcome, Yuvarajan et.al (4) employed cyclo-octanol blends with biodiesel of palm oil as an alternative fuel for diesel engines. Bari and Hossain [5] found that fuel borne oxygen in the palm oil diesel makes the thermal efficiency closer to the diesel. Moreover, they noticed that, due to higher combustion temperature and oxygenated fuel, the NO_X emission with POD was higher than diesel. Srinidhi et.al [6] found that addition of ethanol in blends provide a better thermal efficiency than the blend of biodiesel-diesel. Mathan raj et.al [7] noticed that increase of cotton seed oil content in the blend reduces the emission levels with the increased amount of HC emission. Ali et.al [8] studied the changes in the properties of fuel when alcohols and ether are blended with palm oil biodiesel.

Pedro Benjumea et.al [9] measured the several palm oil biodiesel-diesel fuel blends properties with the reference of ASTM standards, and also the mixing rules to predict the properties of fraction volume of biodiesel in the blend. Araby et.al [10] developed different correlations to determine the best blending mixture. Velmurugan and Shaafi [11] conducted the experiment for the performance and emissions of a DI Simpsons Tractor Diesel engine with three different fuels namely Diesel, WCO (B100) and DWME (B20) blend. They found that thermal efficiency of the B20 blend was lower when compared with other fuels used, and the temperature of the exhaust are high for B20 blend.

In the present experimental work, an attempt was made to analyze the performance, and emission characteristics of a twin cylinder Direct Injection Simpsons make (S217) CI engine running on Diesel, Palm oil (B100) and Diesel – Palm oil biodiesel (B20) blend.

2. BIODIESEL PRODUCTION PROCESS

Palm oil was used to produce biodiesel by using transesterification method. Trans-esterification setup consists of a reflux condenser, thermometer and magnetic stirrer. The prepared biodiesel is washed three times with warm water. The residual methanol, water and catalyst were removed from the biodiesel at 80 degree centigrade. Palm oil biodiesel was dried at 100°C. Biodiesel was mixed with diesel oil at the proportions of 20% by volume. Figure 1 shows the photographic views of (a) B20 blend and (b) B100. Density, flash point, CV and cetane index of biodiesel blends were measured and presented in Table 1.

(a) (b)

Figure 1: Photographic view of Biodiesel Blend (a) B20 and (b) Palm Biodiesel.

Table 1: Properties of the Fuel

Fuel	Diesel	B100	B20
Density kg/m^3	830	907	876
Kinematic viscosity	4.2	9.18	3.79
Cetane Number	60	50	62
Calorific value kJ/kg	47108	36000	37418

3. EXPERIMENTAL SET UP

A Simphson, single cylinder, four strokes, and direct injection tractor diesel engine with a power of 21 kW at 1500 rpm was used to carry out the experiment. Experimental setup and technical properties of diesel engine are shown in Figure 2

and Table-2, respectively. Eddy current dynamometer (Model E50) is coupled directly to the test engine to determine engine output brake power. The air flow at intake was measured by using orifice. U tube manometer was employed to measure the pressure differences across the orifice. Temperature measurements at intake air manifold and exhaust gas were measured by using K type thermocouple. The smoke opacity and exhaust gas concentrations (CO, HC, CO2 and NOX) were measured by using AVL smoke meter and five gas analyzer, respectively. The engine was tested by applying 0 to 100 % loads by maintaining a1500 rpm as a constant speed.

Figure 2: Photographic view of Experimental Setup.

Table 2: Technical Properties of Diesel Engine

Model	SIMPSON S 217
Capacity	21 kW
Bore	91.44 mm
Stroke	127 mm
No of cylinders	2
Compression ratio	18.5 : 1
Combustion system	Direct Injection

4. RESULTS AND DISCUSSIONS

4.1 Brake Thermal Efficiency

Thermal efficiency for the biodiesel blends (B20, B100) compared to the conventional diesel at all the engine loads are shown in Figure 3. Thermal efficiency reduces for all the biodiesel blends due to higher magnitude of density, viscosity and lower calorific value (LCV).

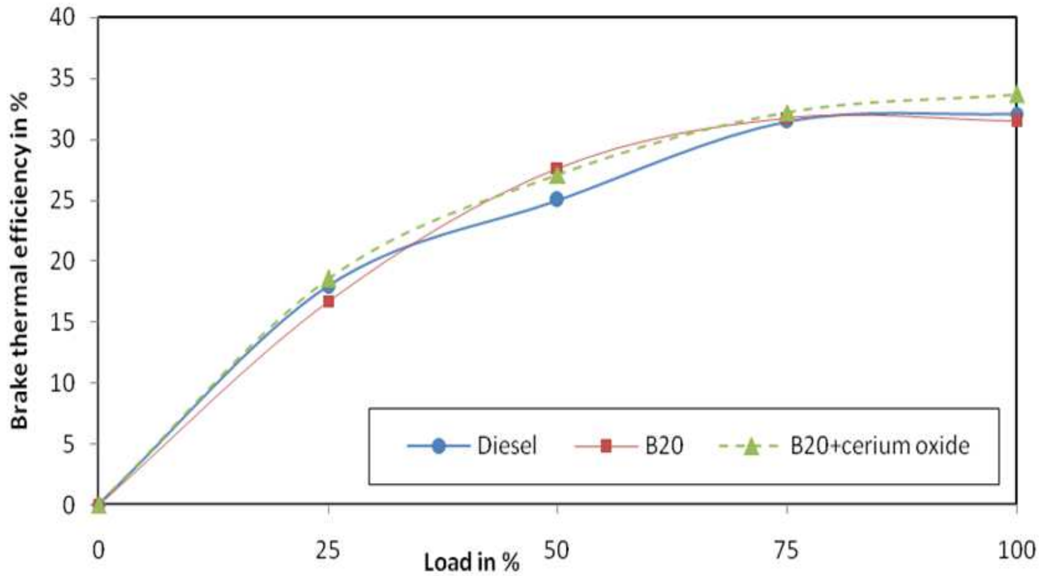

Figure 3: Brake Thermal Efficiency at Various Load.

4.2 Exhaust Gas Temperature

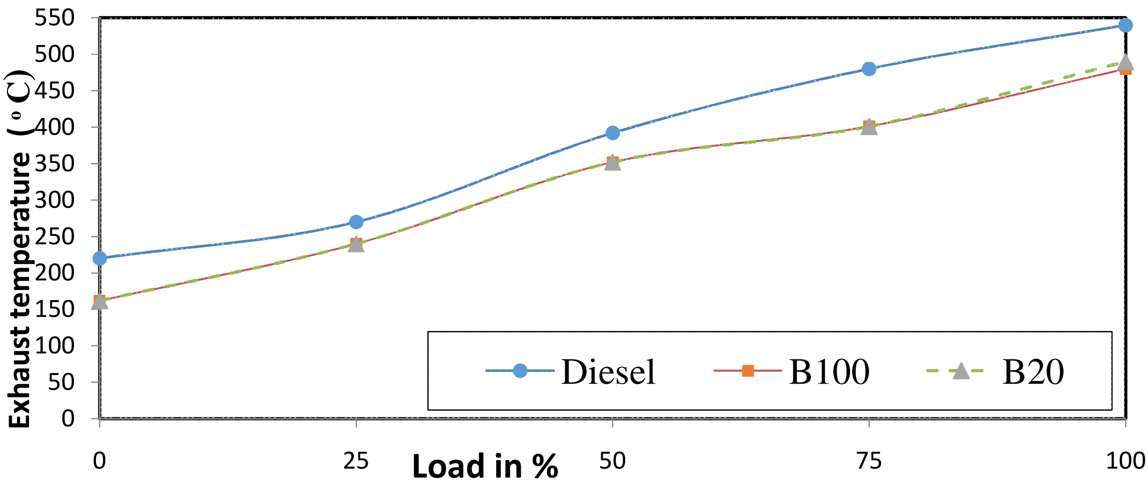

Figure 4: Exhaust Gas Temperature at Various Load.

Temperature of the exhaust gas for the biodiesel blends namely B100, and B20 is shown in Figure 4. Thermal efficiency of POME blends and diesel are reduced due to heat loss taking place in the exhaust. This may be caused due to higher temperature inside the engine cylinder.

4.2 CO Emissions

The percentage of CO emissions at various loads is shown in Figure 5. Due to more molecules of oxygen and very less carbon content present in the biodiesel blends; it leads to complete combustion of the fuels. The palm biodiesel blends molecular structure, helpful for the complete combustion, and also reduces the CO emissions.

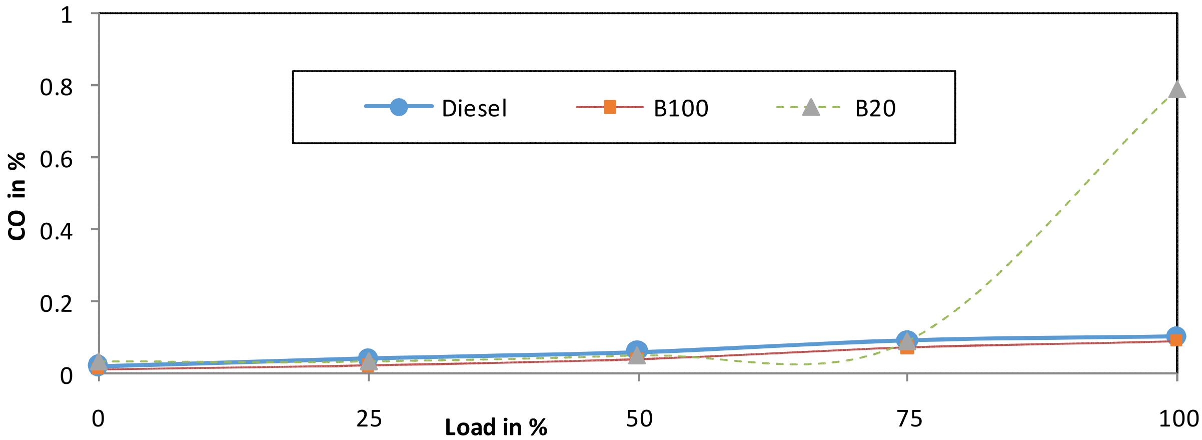

Figure 5: Percentage of CO Emissions at Various Loads.

4.3 Hydro Carbon Emissions

Figure 6 shows the hydro carbon emissions of the tested fuels. Hydro carbon emission traces are very low at part load, but it is increased in trend at higher loads of the engine. Higher magnitude of oxygen content leads to lower hydro carbon emissions at full load conditions. At all the loads of the engine with reference to the diesel fuel, there was a small reduction in hydro carbon emissions for palm biodiesel blends. Adding biodiesel to diesel fuel increases the content of oxygen resulting complete combustion, and these results lower HC emissions.

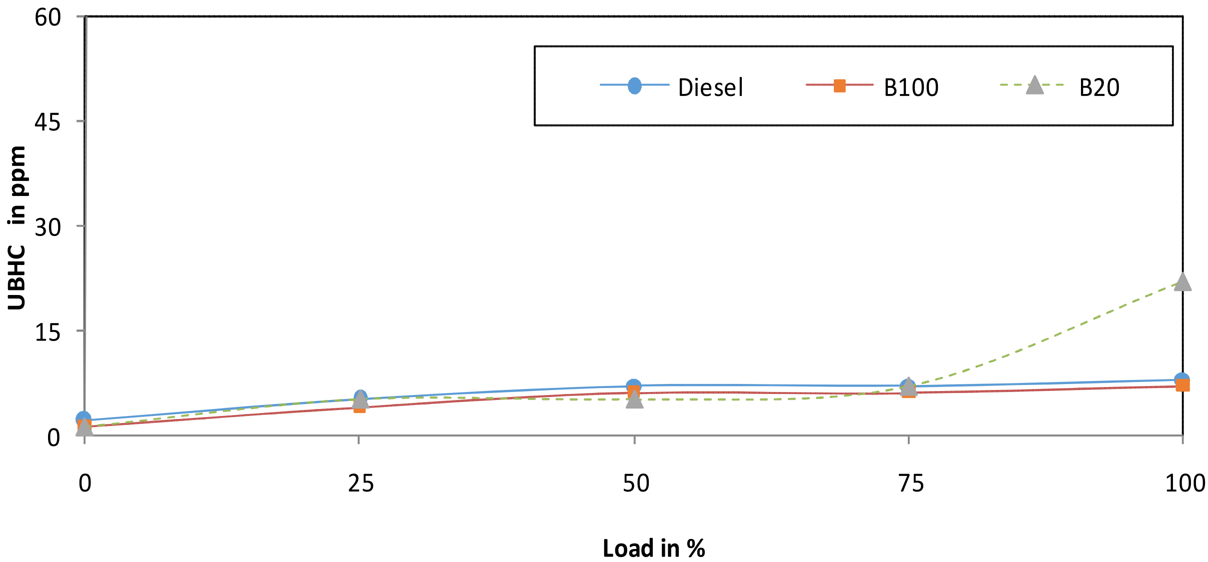

Figure 6: Hydro Carbon Emissions at Various Loads.

4.4 Nox Emissions

NOx emissions with respect to diesel fuel are shown in Figure 7. NOx emissions were increased for all the fuels tested, with respect to the increase in load of the engine. The cylinder temperature was responsible for the NOx formation that was due to the increase in the amount of fuel burned. Diesel engine NOx emissions formation rate depends on the flame temperature.

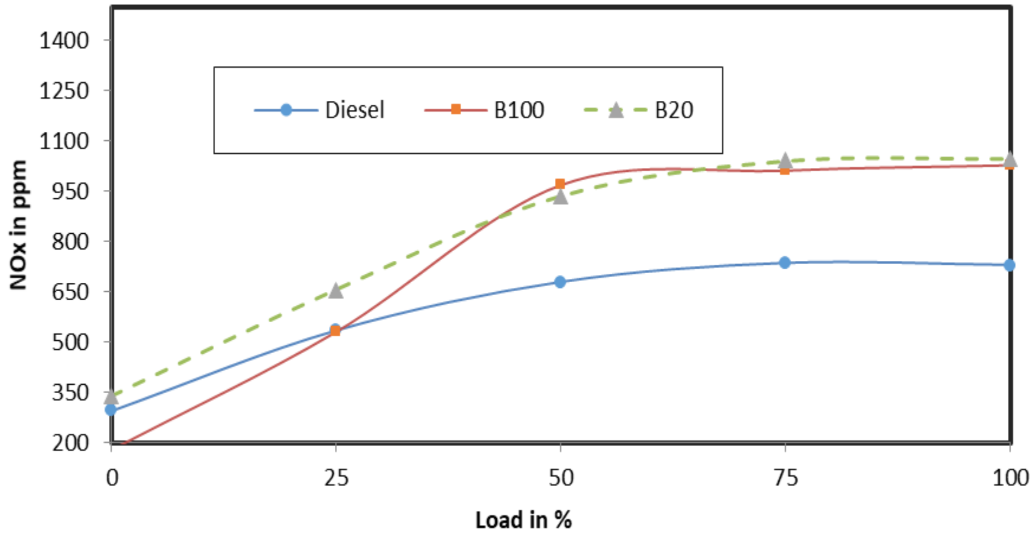

Figure 7: NOx Emission at Various Loads.

5. CONCLUSIONS

A diesel engine consists of twin cylinder was run using B20, and B100. The engine loads are varied (25%, 50%, 75% and 100%) and the performance and emissions of exhaust were measured accordingly. Brake thermal efficiency, temperature of exhaust gas and ratio of air and fuel were measured. Exhaust gas emission contents were recorded and compared with neat diesel fuel. The below mentioned conclusions were arrived:

- POME and blends of POME brake thermal efficiency were lower when it was compared with diesel fuel.
- Carbon monoxide and hydrocarbon emissions were low when compared to the diesel, and at the same time, NOX emissions were higher.
- Diesel with 20% methyl ester of palm oil blend was viable as an alternatvie fuel for diesel engine.

REFERENCES

1. *C. W. Mohd Noor, M. M. Noor, R. Mamat "Biodiesel as alternative fuel for marine diesel engine applications: A review" Renewable and Sustainable Energy Reviews Vol. 94, 127-142, 2018.*
2. *Sharzali Che Mat, M. Y. Idroas, M. F. Hamid, Z. A. Zainal "Performance and emissions of straight vegetable oils and its blends as a fuel in diesel engine: A review" Renewable and Sustainable Energy Reviews, Vol. 82, 808-823, 2018.*
3. *Sriram, V., Jeyajeevahan, G., Brittojoseph, G., & Durairaj, R. (2017). Engine Performance and Emission Characteristics of 1-Octanol Blended Bio-diesel in a Single Cylinder Diesel Engine. Stroke, 2000, 110.*
4. *Baharak Sajjadi, Abdul Aziz Abdul Raman, Hamidreza Arandiyan "A comprehensive review on properties of edible and non-edible vegetable oil-based biodiesel: Composition, specifications and prediction models" Renewable and Sustainable Energy Reviews Vol.63,.62-92, 2016.*
5. *Yuvarajan Devarajan, Dinesh Babu Munuswamy, Arulprakasajothi Mahalingam, Beemkumar Nagappan "Performance, Combustion, and Emission Analysis of Neat Palm Oil Biodiesel and Higher Alcohol Blends in a Diesel Engine" Energy Fuels, 31, 12, 13796-13801, 2017.*

6. S. Bari, S. N. Hossain "Performance and emission analysis of a diesel engine running on palm oil diesel (POD)" Energy Procedia 160, 92–99, 2019.
7. Senthilkumar, P. Environmental Effect of using Diesel on Waste Plastic Oil Fueled in DI Diesel Engine.
8. C, Srinidhi, S. V. Channapatna, A. A. Pawar, A. Madhusudhan "Performance and Emissions of Diesel Engine fuelled with ethanol and Palm Oil Methyl Ester, International Research Journal of Engineering and Technology Vol. 03 Issue:: 04, 2016. |
9. V. Mathan Raj, L. R. Ganapathy Subramanian, G. Manikandaraja "Experimental study of effect of isobutanol in performance, combustion and emission characteristics of CI engine fuelled with cotton seed oil blended diesel" Alexandria Engineering Journal, Vol.57, Issue 3,1369-1378, 2018.
10. Rajesh, S., Kulkarni, B. M., & Shanmukhappa, S. (2014). Investigations on fuel properties of ternary mixture of ethanol, bio diesel from acid oil and petroleum diesel to evaluate alternate fuel for diesel engine. International Journal of Research in Engineering and Technology, 2(6), 181-188.
11. Obed M. Ali, Talal Yusaf, Rizalman Mamat, Nik R. Abdullah, Abdul Adam Abdullah, "Influence of Chemical Blends on Palm Oil Methyl Esters' Cold Flow Properties and Fuel Characteristics" Energy, 7, 4364-4380, 2014.
12. Pedro Benjumea, John Agudelo, Andres Agudelo "Basic properties of palm oil biodiesel–diesel blends" Fuel 87, issue 10-11, 2069–2075, 2008.
13. R. El-Araby, Ashraf Amin, A. K. El Morsi, N. N. El-Ibiari, and G. I. El-Diwani "Study on the characteristics of palm oil–biodiesel–diesel fuel blend" Egyptian Journal of Petroleum, Vol. 27 issue 2, pp.187–194, 2018.
14. Senthilkumar, P., & Sankaranarayanan, G. (2015). Production of waste polyethylene bags in to oil and studies performance, emission and combustion characteristics in di diesel engine. International journal of humanities, arts, medicine and science, 3, 149-158.
15. Velmurugan. K, Shaafi. T "Performance and emission characteristics of a twin cylinder di diesel engine running on diesel -waste cooking methyl ester blend" International Journal of Mechanical and Production Engineering Research and Development, vol.9 issue 6, pp.183-190.

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